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Fairchild, L.G.

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9. ABSTRACT

This study sponsored by the Policies for Science and Technology in Developing Nations at Cornell University is one part of a multi-country project and was designed to provide a comparison of the behavior of joint ventures and Mexican firms with special reference to product and process innovation and sources of technology. The sample includes 25 firms with direct U.S. equity and matching firms with one hundred percent Mexican capital. Interviews were conducted with general managers and statistical data for individual firms were used to provide the basis for comparison of innovative activity and sources of technology used by the Mexican and joint venture firms. Their relative performance was measured in terms of profitability, growth and export-orientation. It was concluded that Mexican companies' performance was equal to joint ventures and their survival is not threatened by this competition. The managers of the Mexican firms believe they have competed so well because they know the Mexican market and have no time lags waiting for decisions from outside the country. There is no evidence to show that joint ventures are more innovative; the evidence shows slightly greater innovation by Mexican firms. More Mexican firms added products at increasing levels of sophistication, and Mexican firms initiated more changes in production processes. The evidence indicates that Mexican firms compete well by relying, not on foreign technology, but on local consultants who are often drawn from the universities, and on the firms' own internal technical capabilities. This conception of the Monterrey industrial community differs significantly from that in a large part of the "dependency" literature.

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AN EXAMINATION OF MANUFACTURING FIRMS  
IN MONTERPEY, MEXICO: PERFORMANCE AND  
SOURCES OF TECHNOLOGY

by

Loretta (Good) Fairchild

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This study was designed to provide a comparison of the behavior of joint ventures and Mexican firms<sup>2</sup> with special reference to product and process innovation and sources of technology. In addition, at the conceptual level, it was designed to contribute to the empirical data related to "dependency" theory, which suggests that national industry in Latin America has been co-opted by the multinational firm, in part because of their relative disadvantage in the area of science and technology, and consequently are incapable of providing dynamic impetus to the development process in line with national objectives.

By all accounts, if there is a concentration of national industry in all of Latin America that is maintaining its dynamism and independence both of the national government and the multinational firm, and has supported an advanced technological institute, which in turn services the industrial community, that concentration should be found in Monterrey, Mexico.

Indepth interviews with general managers and statistical data for individual firms were used to provide the basis for comparison of innovative activity and sources of technology used by the Mexican and joint venture firms, and their relative performance, measured in terms of profitability, growth and export-orientation.

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<sup>1</sup>This study is one part of a multi-country project. Similar research will be conducted in Brazil, Colombia and Venezuela during 1975. The author gratefully acknowledges the assistance of Tom E. Davis and Jerry L. Ingles in the development of the research design and analysis.

<sup>2</sup>The sample includes 25 manufacturing firms in Monterrey, Mexico, with direct U.S. equity and a matching firm for each with 100% Mexican capital. The firms were interviewed by Loretta Fairchild (nee Good) in 1969 and again in 1974. Further information on the make-up of the sample is found in addendum A.

Static indicators used to measure performance for the two groups of firms include return on equity<sup>1</sup>, return on capital<sup>2</sup> and export orientation. (see Table 1). There are no significant differences in level of performance between the two groups. In 1969, return on equity was virtually identical for the two groups. Return on investment appears slightly higher for the joint ventures but the difference is not significant at the five percent level. By 1973, profitability has increased for both groups of firms but there is still no significant difference.

A general expectation about JV superiority in exporting was clearly not valid for these firms since the percentage of sales exported was the same for both groups as of 1969 and the number of joint venture firms doing any exporting fell very sharply after 1969<sup>3</sup> while the number of Mexican firms exporting rose.

A second way to compare the two groups' performance is perhaps superior in that it minimizes the effects of between-industry variation by measuring the difference in performance between a Mexican company and its joint venture counterpart.<sup>4</sup> None of the mean differences was

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<sup>1</sup>Return on equity was calculated as before-tax net profit divided by net worth.

<sup>2</sup>Return on investment was calculated as before-tax net profit divided by total assets. Using fixed assets as the denominator yielded similar results. Figures in parentheses are standard deviations, for ease in estimating levels of significance.

<sup>3</sup>Several exporters among the Mexican firms indicated that their percent of sales exported was lower in 1973 because of greatly increased domestic sales, not because of any decrease in sales abroad.

<sup>4</sup>Differences for each variable were calculated as: Mexican performance value minus that of its joint venture counterpart. A Student-t, two tailed test was used to determine whether or not the average of the differences was significantly different from zero. Because of the direction of subtraction the average will be negative when the JV's did better than the Mexican firm and positive when the Mexican firm was superior. See Addenda A for further information on criteria for matching firms and sample characteristics.

Table 1. Static Performance Measures<sup>a</sup>

	1969		1973	
	Mexican Firms	Joint Ventures	Mexican Firms	Joint Ventures
<b>Profitability:</b>				
Return on equity	11.5% ( 7.4)	14.1% (16.5)	13.3% (13.1) <sup>b</sup>	17.0% (23.0) <sup>b</sup>
Return on investment	5.8% ( 3.2)	7.2% ( 9.6)	6.6% (19.6) <sup>b</sup>	8.4% ( 9.7) <sup>b</sup>
<b>Exports:</b>				
Percent of Sales Exported	2.8% (9.1)	5.1% (10.7)	2.8% (5.8)	4.0% (11.0)
Percent of Sales Exported <sup>c</sup>	12.8% (6 firms)	12.0% (14 firms)	8.8% (6 firms)	26.6% (3 firms)
Any exports during the period 1969-1973			9 firms	6 firms

<sup>a</sup>Data presented are means for each group, followed by standard deviations in parentheses unless otherwise indicated. \* indicates significance at the 10% level, \*\* for significance at the 5% level, using a two-tailed test.

<sup>b</sup>Medians are presented because the means are distorted by a few extraordinary values. Nevertheless, none of these means are significantly different even at the 10% level.

<sup>c</sup>Percentages are means only for the number of firms indicated, i.e. only those with response greater than zero.

Table 2. Static Performance: Means of Differences for Pairs<sup>a</sup>

	1969	1973
<b>Profitability:</b>		
Return on equity	-0.09% (19.36)	-7.4% (19.93)
Return on investment	-1.48% (11.48)	+3.1% (19.71)
<b>Exports:</b>		
Percent of annual sales exported	-2.56% (15.58)	+0.06% (10.11)
Any exports between 1969 and 1973 (yes or no)		+0.71 (3.27) <sup>2</sup>

<sup>a</sup>Differences are calculated as: Mexican performance value minus J.V. performance value, for each industry pair.

<sup>2</sup>Yes-No responses were coded as 5-0 due to an earlier effort to standardize all variables on a 1-5 scale for combining into indices.

significant at the 10 percent level (see Table 2). In other words, on a pair by pair basis, the Mexican companies were as profitable and exporting as much as their joint venture competitor.

Firms' performance over time is indicated by average growth<sup>1</sup> of profits, sales, assets and employment for the two periods, 1966 to 1969, and 1969 to 1973 (see Table 3). On average, the growth rates of net profits for the two groups have been virtually identical over the eight year period. In the first period, the joint ventures had faster growth of sales and employment and slower growth of assets. By the second period, however, the difference on sales is much smaller, and growth rates

<sup>1</sup>Percentages given are annual average rates of growth for before-tax net profits, net sales, total assets and total employment.

Table 3. Dynamic Performance Measures

	1966 - 1969		1969 - 1973	
	Mexican Firms	Joint Ventures	Mexican Firms	Joint Ventures
<b>Growth: (annual average)<sup>b</sup></b>				
of Profits	15.4% (21.0)	15.4% (22.1)	15.6% (50.5) <sup>a</sup>	15.5% (35.1) <sup>a</sup>
of Sales	11.9% (13.0)*	19.1% (16.6)*	11.9% (10.2)	15.0% ( 7.6)
of Assets	19.7% (18.5)	15.0% (12.9)	12.5% ( 9.8)	9.5% (11.6)
of Total Employment	6.8% (21.5) <sup>a</sup>	8.2% (7.6) <sup>a</sup>	2.6% (9.8) <sup>b</sup>	6.0% (7.5) <sup>b</sup>

<sup>a</sup>Medians are presented because the means are distorted by a few extraordinary values; they are not significantly different even at the 10% level, however.

<sup>b</sup>Barely significant at the 20% level.

\*Indicates significance at the ten percent level.

for assets are slightly lower and virtually identical for both groups.

The same picture is brought out even more clearly by the means of differences of growth rates for each pair (see Table 4). In the 1969 period, the joint ventures were growing significantly faster than their Mexican counterpart in sales and total employment. However, by the later period, growth rates have tended to equalize so that existing differences are not significant.

On the basis of the 1969 results, it was concluded that the Mexican companies were performing "on par" with the JV's so that their survival was not seriously threatened by this foreign competition.<sup>1</sup> It was predicted also that growth patterns over time were tending to mitigate, rather than intensify, existing differences. The evidence from the second survey, through 1973, would seem to support and reinforce both conclusions.

What factors are enabling the Mexican firms to compete so well? That question was asked of the businessmen<sup>2</sup> when they were re-interviewed in 1974. All but one agreed that the study's conclusion that the Mexican firms were performing equally with the JV's was probably accurate. However, the reasons suggested by the two groups were very different.

One half of the general managers in the joint ventures<sup>3</sup> believed that the Mexican firms were roughly equal chiefly because they relied on foreign technology. The other half suggested that the Mexican companies were

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<sup>1</sup> See Loretta Good, United States Joint Ventures and National Manufacturing Firms In Monterrey, Mexico: Comparative Styles of Management. Doctoral Dissertation, Economics, Cornell University, August, 1972.

<sup>2</sup> Opinions are available only from 8 Mexican firms and 6 joint venture firms.

<sup>3</sup> Of the joint venture managers expressing opinions, 50% were Mexican and 50% percent were American.

Table 4. Dynamic Performance: Means of Differences Between Pairs

	1966 - 1969	1969 - 1973
<b>Growth:</b>		
of Profits	-0.21% (20.20)	-1.72% (64.39)
of Sales	-8.58% (24.50)*	-1.89% (11.08)
of Assets	+2.50% (19.22)	+2.16% (15.32)
of Employment	-4.83% (10.62)**	-2.87% (11.51)

\* Indicates significance at 10% level.

\*\* Indicates significance at 5% level or less.

making high profits because of questionable management practices, for example, using "outdated" technology and realizing unsustainably high profits because they are not re-investing. It was also mentioned that the two groups could not really be compared since their markets were essentially different: only domestic for the Mexican firms and "international" for the joint ventures.

On the other hand, general managers of the Mexican firms suggested that the Mexican companies were doing equally well because of some advantages in being national and various disadvantages of having foreign capital. They stressed the importance of knowing the Mexican market, the fact that foreign technology is transferred with no changes and is badly adapted to local conditions, and that long lags as the firm waits for decisions "from New York" are detrimental. Finally, foreign executives are also seen as primarily concerned with how they appear in their "division," so they focus on dividends and "bleed" the Mexican operation, jeopardizing its long-run growth.

Opinions among both groups were split evenly on whether or not Mexican companies have any advantage in terms of consumer preference or getting credit, but they were considered to have an advantage in any dealings with the government, such as import permits. On the question, do foreign firms really try less hard because they feel vulnerable, opinions were evenly and sharply divided in both groups.

An examination of the empirical data provides some insight on the validity of these opinions, and is at least suggestive of why the Mexican firms are performing so well.

One variable which, according to development literature, should provide significant competitive advantage to the joint ventures, is access to technology that results in process and product innovation. The data fail to show that the joint ventures are significantly more innovative<sup>1</sup> than the national firms (see Table 5). Instead, while performance was very nearly equal, the slightly significant differences which do exist indicate greater Mexican innovativeness.

With respect to product changes,<sup>2</sup> by the later period, more Mexican firms added products at increasing levels of sophistication, while for the JV's, roughly twenty percent made no changes in either period and the

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<sup>1</sup>Innovation is used here to refer to changes which have been introduced, not to R & D activity which might or might not lead to tangible results.

<sup>2</sup>"Type" refers to an area of products, all of which are made of the same raw materials. A "line" is a subcategory of products within a type, which all have the same specific function. (It is analogous to general names of products: motors, pumps, enamel paint, etc.) If different raw materials are used but the processing is the same, it would still be considered a single line. "Model" variations are changes only in designs; colors, styles or sizes.

Since the categories were ranked in order of increasing complexity, the difference in "complexity of product introduced" indicates that one firm is "one step" or "two steps" ahead or equal with its competitor.

Table 5. Innovation

	Mexican Firms	Joint Ventures	Differences (Mex - JV)
<b>1969 Survey</b>			
1. Most complex product change made			
model variation	26.7%	48.6%	-0.28 (1.72) <sup>a</sup>
new lines	40.0%	20.0%	
new types	3.3%	14.3%	
any changes	70.0%	82.9%	
2. Percent of new processes <sup>b</sup>	20.0%	21%	+0.31 (2.475)
3. Any changes in processes, within 3 years (yes)	70.0%	48.6%	+1.0 (3.57) <sup>c</sup>
4. Products dropped in last 5 years	46.4%	28.0%	
<b>1973 Survey</b>			
1. Most complex product change made			
new types of products added <sup>e</sup>	8.0%	3.7%	0.17 (0.49) <sup>d</sup>
new lines of products added <sup>e</sup>	56.0%	44.4%	+0.22 (1.83)
model variations	36.0%	29.6%	0.65 (3.47)
any changes	100.0%	77.7%	
2. Percent of new processes <sup>e</sup>	27.9%	20.2%	+9.09 (32.76) <sup>f</sup>
3. Any change in processes, with 3 years	68.0%	70.3%	0.0 (2.61)

<sup>a</sup>Figures in parentheses are standard deviations.

<sup>b</sup>"New" is introduced within the last 6 years.

<sup>c</sup>The average difference here is positive, indicating typical Mexican changes, when their JV partners had introduced none. The mean of the difference is significantly different from zero at the 15% level.

<sup>d</sup>Significant at 15% and very nearly significant at the 10% level.

<sup>e</sup>"New" is introduced within the last 3 years.

<sup>f</sup>Almost significant at the 20% level.

percentage making the most complex changes decreased. Mexican superiority in the second period in the complexity of products added is almost significant at the ten percent level.

Although roughly the same percentage of both groups indicated that some changes in production processes<sup>1</sup> had been initiated, the size of changes was nearly one-third higher for the Mexican firms in the later period and the difference seems to have been increasing over time.

This strong level of innovativeness by the Mexican firms might be the cause or the consequence of the fact that they are relying heavily on imported foreign technology, brought in under technical assistance contracts, etc. or from foreign technicians. However, this tempting hypothesis is not confirmed by the data.

Between the two periods, as innovativeness by Mexican companies increased, their utilization of patents and technical assistance contracts, etc. was low and did not increase (see Table 6). In the second period, twice as many JV's had technical assistance contracts,<sup>2</sup> and four times as

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<sup>1</sup>The general manager was asked to estimate the percentage of processes currently in use which were not in use 3 years earlier, to get an indication of recent innovative activity. Such "guesstimates" will vary in validity comparing among industries. However, pairing of the firms within product classification minimizes these difficulties. Further analysis (see Monograph #2, appearing shortly) has indicated that differences in percent of new processes added is significantly related to relatively successful performance on growth variables during the second period. Since it was often difficult to get a precise estimate of the change, a related question (were any significant changes in production introduced in the last 3 years--yes/no) was also used. Firms giving specific percentage responses are also included in this latter category. The question on products dropped recently was omitted from the 1973 questionnaire in the interest of brevity. Percentages given indicate those firms out of the total, giving a "yes" response.

<sup>2</sup>Data was tabulated as the yes/no response to whether or not the firm had utilized any T.A. contract, etc., any time during the period. Figures were also obtained on the number of T.A. contracts, patents and licenses utilized by a particular firm. This information may be overlapping in

Table 6. Use of Documents Related to Technology

	Mexican Firms	Joint Ventures	Differences Between Pairs
<b>1969 Survey</b>			
1. Number of firms with U.S. T.A. contracts	7	20	-2.14 (2.86)**
Number of firms with foreign T.A. contracts	1	1	0.0 (1.36)
2. Number of firms with any U.S. patents	5	16	-1.90 (3.11)**
Number of firms with any foreign patents	0	2	-0.34 (1.29) <sup>b</sup>
<b>1973 Survey</b>			
1. Number of firms with U.S. T.A. contracts	8	16	-0.32 (0.95) <sup>b</sup>
Number of firms with foreign T.A. contracts	3	4	-0.09 (0.67)
2. Number of firms with U.S. patents	3	11	1.95 (13.04)
Number of firms with foreign patents	2	2	-1.00 (4.47)
3. Number of firms with U.S. licenses	2	9	-0.14 (0.48) <sup>b</sup>
Number of firms with foreign licenses	1	4	-0.09 (0.43)
4. Average royalties paid: <sup>a</sup> 1969	54	63.8	-46.9 (92.1)**
	(7 firms)	(20 firms)	
Average royalties paid: <sup>a</sup> 1973	105.6	109.4	
	(5 firms)	(14 firms)	
5. Average of royalties/net sales: 1969	0.50% (.011)**	1.97% (.027)**	-0.03 (0.03)**
Average of royalties/net sales: 1973	0.45% (.011)**	2.06% (.029)**	-0.02 (0.03)*

<sup>a</sup>Averages, in 1,000's of U.S. dollars, for the number of firms shown, i.e. those paying any royalties.

\*\* Means significant at 5% level or above.

\* Means significant at 10% level.

<sup>b</sup> Means significant at 20% level.

many were using U.S. patents and/or licenses.<sup>1</sup> Only 12 of the 25 Mexican companies had any kind of formal contract with the U.S. or any other country and for three of them the agreements had expired sometime during the period. Thus, for only 9 companies (36%) were these contracts operational as of 1974.

Estimates on royalties<sup>2</sup> show this same trend: Few Mexican firms paid any and the number paying royalties decreased over time.

Foreign technical information may also be received embodied in people. However, Mexican firms throughout both periods seem to have relied very little on foreign engineers, either hired directly or brought in as consultants (see Table 7).

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the sense that a particular license may contain an agreement on conveying technology and several patents. At the other extreme, a firm may hold several patents, each one of which is from a separate company and is covered by a separate contract. The adjective "foreign" is used to indicate contracts with all other countries except the U.S.

<sup>1</sup>For the joint ventures, there is a fairly strong tendency for the use of T.A. contracts to be higher for firms with lower percentages of U.S. equity. This is not always the case, of course; for one firm, the percentage of U.S. equity fell from over 80% to 49% without any change in the basic management structure. Even at 49%, no T.A. contract was used and no royalties were charged, even though the firm had originally been allowed 80% as part of an agreement for supplying the technical assistance without charge. Use of brandnames is included with licenses.

<sup>2</sup>In order to gain a clearer understanding of the order of magnitude of royalties being paid, the averages presented are only those for firms paying any.

Figures of royalties to net sales are especially interesting since similar measures are being used by the Registry of T.A. contracts as it evaluates the appropriateness of cost to technology received.

Table 7. Use of Foreign Consultants and Employees

	Mexican Firms	Joint Ventures	Average Differences
<b>1969 Survey:</b>			
Use of U.S. engineering consultants	34.6%	46.9%	-0.83 (3.81)
Use of foreign engineering consultants	0.0%	6.3%	-0.21 (1.02)
# of firms using any U.S. engineers and/or administrators	2	15	-0.94 (1.8)*
Percent of U.S. engineers and/or administrators <sup>a</sup>	8.0% <sup>b</sup>	17.5% <sup>b</sup>	-0.10 (0.17)**
<b>1973 Survey:</b>			
Use of U.S. engineering consultants	16%	44%	-1.25 (2.75)**
Use of foreign engineering consultants	8%	4%	+0.25 (1.12)
# of firms using any U.S. engineers and/or administrators	0	10	
Percent of U.S. engineers and/or administrators <sup>c</sup>	-	18.0%	

<sup>a</sup> Calculated as a percent of the total number of engineers plus administrators in the firm.

<sup>b</sup> Average for those having any foreign engineers or administrators (10% of total for Mex and 58% for JV's)

\* Means significant at 10% level.

\*\* Means significant at 5% level or above.

<sup>c</sup> Average for those having any U.S. personnel, as a percentage of the total number of engineers.

Use of U.S. engineering consultants<sup>1</sup> since 1966 has been higher and consistent for the joint ventures, while for the Mexican firms' utilization fell fifty percent by the second period, causing the higher use by JV's on average to be significant at the one percent level. Only two Mexican firms had hired any U.S. engineers<sup>2</sup> or administrators in the first period and by 1973 none were using any. The slight increase in use of foreign engineers not from the U.S. is interesting and perhaps indicates a decreasing dependency on U.S. technology.

The empirical evidence seems to indicate that Mexican firms are competing well by relying, not on foreign technology brought in through formal channels, but rather on local consultants, often drawn from the Universities, and on the firms' own, internal technical capabilities.

In contrast to the relatively low use of foreign technical consultants, Mexican companies have relied more heavily on Mexican consultants (see Table 8).<sup>3</sup> Perhaps their importance is underscored by the extraordinary jump, between the two periods, in the level of utilization by the joint ventures. Mexican company usage is still significantly greater in both periods.

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<sup>1</sup>Visits from people on the staff of the parent company are not included, as inputs from owners are viewed throughout the study as "internal to the firm." They may or may not be from the same companies with whom a firm has a T.A. contract, etc. "Foreign" refers to all other countries except the U.S.

<sup>2</sup>This second category refers to those on the company's payroll, but brought in specifically because of their expertise; Cubans now living in Mexico, for example, are not included.

<sup>3</sup>Firms' utilization of the area's universities was ranked on the following basis: 0) never, 1) once a year, 2) two - five times per year, 3) once every two months or more. The percentages given are the number of firms which have consulted them at all. It should be noted that firms generally used these institutions for analyzing various materials, etc. and not for the development of new projects or ideas.

Table 8. Use of Mexican Information Sources<sup>a</sup>

	Mexican Firms	Joint Ventures	Mean Differences
1. Consultations with the Monterrey Tec	48%	41%	0.09 (1.47)
2. Consultations with the State University	32%	26%	0.04 (0.64)
3. 1969: Use of Mexican Engineering Consultants	30.8%	9.4%	1.04 (2.94)*
4. 1973: Use of Mexican Engineering Consultants	40%	30%	1.25 (3.19)*

<sup>a</sup>All responses are "yes-no".

Further evidence on the importance of internal sources of information is brought out in another way by the opinions of the general managers on what they considered the most important sources of technical help available to them as they tried to solve specific problems (see Table 9).

For the original technical information<sup>1</sup> used as the firm was founded, approximately 70% of the Mexican companies had relied on the founders or other local technicians, and only 30% had used foreign companies or technicians. For the joint ventures however, 57% had gotten the information from the U.S. partner and 80% had used U.S. companies or technicians.

For the information used in achieving process innovation<sup>2</sup> in the earlier period, 75 percent of the Mexican firms said their own administrators or engineers were the chief source for technical information and only 16% relied chiefly on foreign sources. The joint ventures were evenly split, with 40% relying on their U.S. partner and 40% using ideas from their local administrators and engineers.

Over time, there seems to have been little change among the Mexican firms: they are still relying most heavily on their own "idea people." However, among the joint ventures there seems to be a slight decrease in reliance on the parent; an increasing percentage are centering R & D efforts within the firm<sup>3</sup> and not relying exclusively on foreign R & D.

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<sup>1</sup>In the data presented from the 1969 survey, the "first ranked source of technical information" refers to that utilized when the company was founded, regardless of the ownership structure at that time. For the 1973 survey, however, the same item refers to the chief source the firm used for technical information since 1969.

<sup>2</sup>Firms were asked to rank in order of importance the three most important sources of the ideas used in the changes in processes. Similar information for new products proved less useful because the administrators tended to see himself as the chief source, regardless of where he encountered the idea.

<sup>3</sup>The center of emphasis for R & D was coded separately for attention to changes in products, processes and materials adaptation. The data presented here is a summary for all three categories. Patterns among them did not vary appreciably.

Table 9. Sources of Technical Information

	Mexican Firms	Joint Ventures	Mean Differences
<b>1969 Survey</b>			
1. First ranked source of technical information			0.27 (2.05)
founders or administrators	60%	14%	
local technicians	7%	3%	
non-related U.S. companies	23%	17%	
U.S. technicians	10%	6%	
U.S. partner	-	57%	
2. First ranked source of ideas-new processes			0.44 (2.03)
U.S. partner	-	38%	
local administrators or engineers	75%	42%	
U.S. non-owner company	12.5%	4%	
foreign non-owner company	4%	-	
3. 1969: Center of emphasis for R & D			0.39 (1.9)
only from foreign sources or parent	17%	43%	
in own R & D dept. (or with affiliates)	56%	35%	
<b>1973 Survey</b>			
1. First ranked source of technical information			0.39 (2.32)
U.S. partner	-	44%	
firm's own engineers	56%	26%	
non-related foreign manufacturers	32%	26%	
2. First ranked source of ideas-new processes			-0.33 (1.37)
local administrator or engineers	80%	52%	
foreign firm--owner	-	30%	
foreign firm--non-owner	4%	3%	
3. 1973: Center of emphasis for any R & D--on			1.17 (2.79)*
processes, products or materials			
-- within the firm	56%	48%	
-- service dept. of affiliate firms	20%	33%	

\* Indicates significance at the 10% level.

In addition, there are more objective measures of internal technically oriented activity which perhaps makes this reliance on internal sources possible (see Table 10). Putting formal attention on developing new processes<sup>1</sup> seems to be gaining momentum over time, since relatively few firms were active in this area before 1971, while well over half had begun to do so since that time.<sup>2</sup>

Tangible results have come from this research activity. Mexican firms were developing and registering their own patents<sup>3</sup> significantly more often than their competitors prior to 1969 and the basic trend seems to be continuing. It should also be noted that patents registered does not reflect all the activity in this area. Several firms with "patentable ideas" explained that they had not obtained patents simply because they were afraid this might allow the information to reach the "wrong hands." Or, since the machinery was not for resale, they often felt it was not worth the bother to obtain a patent.

It is most exciting that one-third of the Mexican firms had designed and built some of their own machinery, significantly more than was done by

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<sup>1</sup>Firms' responses tabulated here are simply the yes/no response as to whether or not any formal attention was placed on developing new processes, in each time period, where "formal" would indicate that it had become part of someone's job description, even if he did not work on it full time.

<sup>2</sup>The one area in which joint ventures do appear to be putting relatively more emphasis is on quality control. To qualify for a "yes" indicating formal attention on quality control, the firm had to have at least one person working on it full time. Further work is needed in this area to find out trends and implications.

<sup>3</sup>Firms gave the number of patents they or their engineers had developed and registered in each period. The table indicates the number of firms registering any. The number of patents registered by Mexican firms dropped for the second period. However, this is probably due to the fact that five years is simply too short a period to measure such activity, which traditionally has a long gestation period. Patents developed elsewhere which the firm re-registered in Mexico were explicitly excluded.

Table 10. Internal R & D Activity

	Mexican Firms	Joint Ventures	Mean Differences
1. Some attention on R & D for processes			
-- since before 1971	28%	26%	0.22 (2.19) <sup>c</sup>
-- beginning since 1971	68%	52%	1.09 (3.67) <sup>c</sup>
2. Formal attention on quality control	64%	93%	-1.59 (2.38)**
3. Own patents registered before 1969	5 firms	3 firms	0.91 (2.02)*
Own patents registered since 1969	6 firms	4 firms	0.43 (2.5)
4. Designed and built any of own machinery	33%	15%	1.14 (3.06)*
5. Average amount spent on R & D: <sup>a</sup> 1969	44.0 (10 firms)	22.2 (6 firms)	16.2 (41.9) <sup>b</sup>
Average amount spent on R & D: <sup>a</sup> 1973	40.5 (14 firms)	51.0 (8 firms)	
6. Average of R & D expenditures/net sales: 1969	0.30% (.005) <sub>b</sub>	0.33% (.010) <sub>b</sub>	
Average of R & D expenditures/net sales: 1973	0.55% (.007) <sup>b</sup>	0.21% (.003) <sup>b</sup>	0.003 (0.008)

<sup>a</sup>In thousands of U.S. dollars. Averages are for the number of firms given in parentheses, i.e. those doing any R & D spending. Figures given were "best estimates", not exact data.

\*\* Indicates significance at the 5% level, or better.

\* Indicates significance at the 10% level.

b. Indicates significance at the 15% level.

c. Indicates significance at the 20% level.

the joint ventures, in contrast to assumptions generally made that L.D.C.'s are not producing any of their own technology.

R & D expenditures are still relatively small scale but their very existence, and the fact that more and more Mexican firms are spending on R & D would seem to have important implications for Mexico's technological future.

In the area of manpower training,<sup>1</sup> behavior is again very similar between the Mexican and joint venture firms (see Table 11). Approximately two-thirds of all the firms in the sample provide training for employees at all levels, (workers, engineers and managers) utilizing their own resources and those within the community. Mexican firms are even more likely to send their engineers outside of Mexico for training than are the joint ventures. Over time there seems to be a small decrease in the level of such activity, perhaps an indication that Mexico's demand for skilled technicians is gradually being met.

Estimated training expenditures are roughly parallel for the two groups and fairly constant over both periods.<sup>2</sup>

In the light of this evidence of relatively more internal R & D activity among Mexican firms, it is most interesting that managers of the Mexican firms perceived much greater obstacles for their firms in obtaining

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<sup>1</sup>The form of the question was the yes or no response as to whether or not the firm provides training for skilled labor or engineers at programs located within the firm, given by the firm's own personnel or by people brought in from outside, or at community institutions such as Centro Patronal or the Monterrey Tec.

<sup>2</sup>It should be emphasized that the figures for training expenditures both in 1969 and 1973 are strictly estimates since separate records of such expenditures are generally not maintained. Therefore the exact magnitudes are quite indefinite and represent only the general managers' "best guesstimate" of the amount that has been spent.

Table 11. Training Provided by Companies

	Mexican Firms	Joint Ventures	Mean Differences
<b>1969 Survey</b>			
1. Training for workers within the firm	72.0%	66%	0.19 (3.5)
Training for workers within the community	34.5%	63%	-1.67 (3.4)
2. Training for administrators within the community	75%	79%	0.0 (3.01)
Training for administrators out of Mexico	18%	17% <sup>a</sup>	0.43 (2.08)
Training for administrators at U.S. parent company	-	41%	-
3. Estimated training expenditures: <sup>b</sup> 1969	15.0 (17 firms)	5.8 (22 firms)	6.1 (18.6) <sup>d</sup>
Estimated training expenditures: 1973	7.7 (12 firms)	10.1 (12 firms)	-
<b>1973 Survey</b>			
1. Training for skilled labor within the firm <sup>c</sup>	56%	52%	0.22 (3.53) <sup>d</sup>
Training for skilled labor within the community	48%	67%	-1.30 (3.75)
2. Training for engineers within the community	64%	56%	0.21 (3.53)
Training for engineers out of Mexico	56%	48%	0.0 (3.37)
Training for engineers at U.S. parent company	-	59%	-
4. Estimated training expenditures/net sales: 1969	0.19% (.003)	0.21% (.004)	.0001 (.0026) <sup>d</sup>
Estimated training expenditures/net sales: 1973	0.10% (.0008)	0.09% (.0009)	-.0005 (.0011) <sup>d</sup>

<sup>a</sup>At foreign, non-parent companies, or universities, etc.

<sup>b</sup>In thousands of U.S. dollars; figures are averages for the number of firms shown, i.e. those supplying any information.

<sup>c</sup>All answers are "yes-no" responses.

<sup>d</sup>Significant at the 20% level.

needed technology (see Table 12). Very few joint ventures felt that there were any obstacles, even though the Mexican firms are introducing the most changes. Managers were asked to rank in importance the obstacles they had faced in obtaining technology. The two most common responses were 1) that the level of automation was too high for the Mexican market or 2) that the technology was available but too costly.

Difficulty in obtaining technical information seemed to vary substantially by industry, chiefly between those perceived as "open" rather than "closed." When very specialized technology is used, only people within the industry are likely to be knowledgeable about the latest developments. If an industry is "open," if competitors talk to each other, much more information seems to be available for fomenting new ideas. Perhaps industry behavior with respect to communication channels is a variable which should be explored more explicitly in the future.

In considering these attitudes toward the search for technical information, it is interesting to speculate that perhaps since the joint venture firms have an established "channel", i.e. from the U.S. parent company, the entire issue of obtaining technology creates less anxiety since less search is needed, and therefore less activity is undertaken. The basic position of the subsidiary might be considered passive.

For the Mexican firms, on the other hand, the problem looms larger, they are more "anxious" and uncertain about what can and should be done but they are therefore more active--which shows up in the performance and innovation variables.

In conclusion, the conception of the Monterrey industrial community suggested by these data differs significantly from that contained in a large part of the "dependency" literature. Not only are established

Table 12. Obstacles in Obtaining Technical Information

	Mexican Firms	Joint Ventures	Mean Difference
Face significant obstacles in obtaining technology needed? (yes)	48%	18%	1.7 (3.2)**
Chief obstacle on obtaining technology			
-- level of automation too high for Mexican market	20%	22%	
-- too costly	16%		

\*\*Significant at the 5% level.

Mexican firms in a broad range of industries performing comparably with foreign firms in terms of profitability, growth and exports, but they appear to be at least as innovative in the sense of introducing new products and productive processes. Perhaps even more important, they appear to be relying substantially on domestic institutions, and particularly resources internal to the firm, to generate the new technology. To say the least, a national industrial base, not subordinated by foreign competition, appears to be alive and well and living in Monterrey.

Addendum A: Composition of the Sample.

The initial interviews were conducted during the period 1969 to 1971. These same manufacturing firms were reinterviewed during June and July of 1974. Manufacturing firms are included from the following five product classifications: 1) metal products; 2) non-metallic minerals such as glass, bricks, etc.; 3) chemicals; 4) food, beverages and tobacco; and 5) assembly. Each one of the joint venture firms has some U.S. direct equity investment. Each one was then matched with a firm which has 100% Mexican capital and makes basically the same product. Wherever possible, the chief competitor was chosen. Other matching criteria were size, measured in terms of net sales, and age. Only firms in operation more than three years were included since it was felt that the behavior patterns of newer firms were too erratic to indicate general or average performance.

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Table 1. Characteristics of the Sample

	1969		1973	
	<u>Mexican Firms</u>	<u>Joint Ventures</u>	<u>Mexican Firms</u>	<u>Joint Ventures</u>
Age, in 1969	18	13		
Size:				
Total Assets <sup>a</sup>	1.1	1.7	2.7	2.6
Net Sales <sup>a</sup>	1.8	2.3	4.2	3.9
Total Employment	180	160	257	236

a: millions of U.S. dollars

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The smallest firm included in the initial sample had annual net sales of 80 thousand dollars, while the largest had net sales of over 200million dollars. As of 1973, both groups on average had virtually identical total assets. Net

Sales were slightly larger for the Mexican firms but the difference is not significant. Total employment was also essentially the same.

The period 1969 to 1973 was characterized by tremendous growth for Mexican industry in general, although they were very difficult years. Mexico suffered a fairly severe recession during 1970 and 1971. Inflation has been worse than in the United States throughout the period and most recently manufacturers have faced a severe scarcity of raw materials.